**Hypertonic, Hypotonic, and Isotonic Solutions Vocabulary Clarification**

Ms. Ottolini, AP Biology

In freshman biology, you are taught the following definitions of hypotonic, hypertonic, and isotonic solutions:

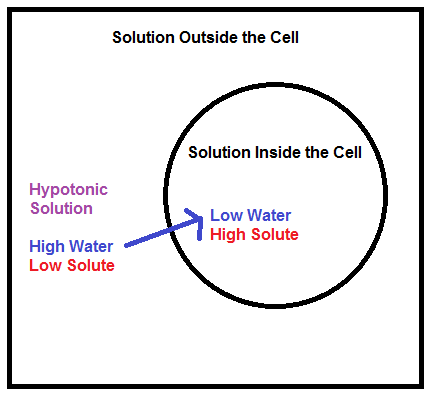
***Hypotonic Solution –*** Has a high water and low solute concentration compared to the solution on the other side of the membrane

***Hypertonic Solution*** – Has a low water and high solute concentration compared to the solution on the other side of the membrane

***Isotonic Solution*** – Has the same water and solute concentrations as the solution on the other side of the membrane

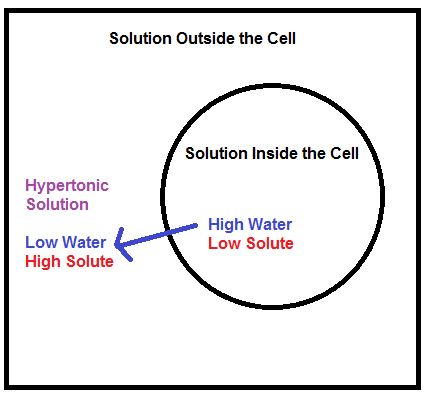
We are also taught that water should move from a high water concentration to a low water concentration.

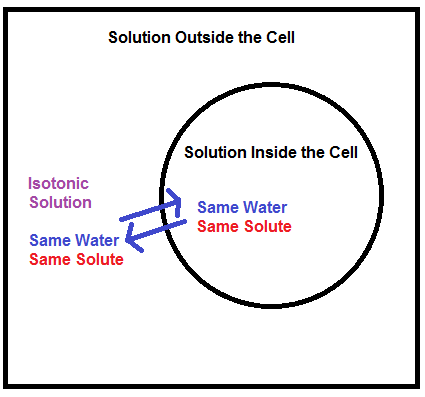
In freshman biology, we assume that the solution being described as hypotonic, hypertonic, or isotonic is on the OUTSIDE of the cell. Therefore, based on that assumption, we can use the following memory tricks…



1. When placed in a hypotonic solution, the cell is like a hippo, it drinks all the water and gets bigger. This happens because a hypotonic solution has a high water concentration, so water should move from a high water concentration outside the cell across the membrane towards a low water concentration inside the cell (see image to the right). In other words, the cell should gain water and swell.

*Note: The arrow shown in the image indicates the direction of water movement.*

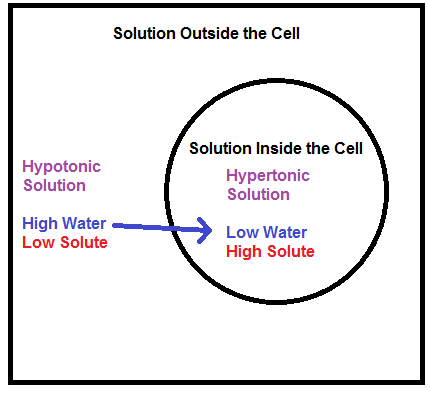
1. When placed in a hypertonic solution, the cell is very hyper. It moves around a lot and sweats (loses water). This happens because a hypertonic solution has a low water concentration, so water should move from a high water concentration inside the cell across the membrane towards a low water concentration outside the cell (see image to the right). In other words, the cell should lose water and shrink.



1. When placed in an isotonic solution, the cell says “I so happy!”… it does not want to gain or lose water. This happens because an isotonic solution has the same water concentration as the solution on the other side of the membrane, so there will be no net (overall) movement of water either into or out of the cell. Water WILL move across the membrane due to random molecular movement, but it will move into and out of the cell at the same rate (see image to the right). In other words, the cell should stay the same size

In AP biology, we do NOT assume that the solution being described as hypotonic, hypertonic, or isotonic is on the outside of the cell. It could be inside the cell as well! Therefore, we cannot always use the same memory tricks, so we have to remember the definitions given at the top of the page for hypotonic, hypertonic, and isotonic solutions.

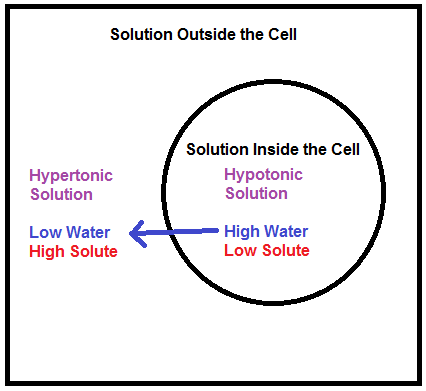
The following scenarios and associated explanations may help you to better understand this new perspective.



1. If the solution outside a cell has a higher water concentration than the solution inside the cell, then the solution outside the cell can be described as hypotonic (high water and low solute concentrations), whereas the solution inside the cell can be described as hypertonic (low water and high solute concentration). Water should move from a high concentration outside the cell across the membrane towards a low water concentration inside the cell. (So… water is moving from a hypotonic solution to a hypertonic solution). In other words, the cell should gain water and swell.

1. If the solution inside the cell has a lower water concentration than the solution outside the cell, then (like in #1) the solution outside the cell can be described as hypotonic (high water and low solute concentrations), whereas the solution inside the cell can be described as hypertonic (low water and high solute concentration). Water should move from a high concentration outside the cell across the membrane towards a low water concentration inside the cell. (So… water is moving from a hypotonic solution to a hypertonic solution). In other words, the cell should gain water and swell.

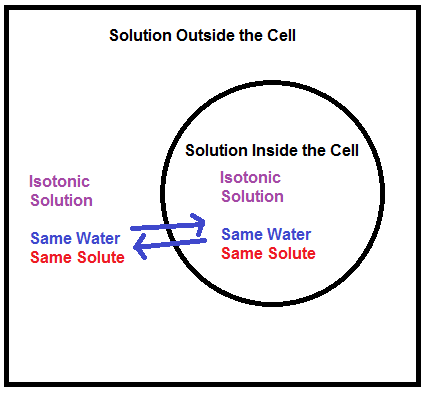
*Note: The image at the top right corner of the page corresponds to BOTH scenarios 1 and 2 because they are the same scenario but with different given information. Scenario 1 identifies the water concentration of the solution outside the cell, whereas Scenario 2 identifies the water concentration of the solution inside the cell.*



1. If the solution outside a cell has a lower water concentration than the solution inside the cell, then the solution outside the cell can be described as hypertonic (low water and high solute concentrations), whereas the solution inside the cell can be described as hypotonic (high water and low solute concentrations). Water should move from a high concentration inside the cell across the membrane towards a low water concentration outside the cell. (So… water is moving from a hypotonic solution to a hypertonic solution). In other words, the cell should lose water and shrink.

1. If the solution inside the cell has a higher water concentration than the solution outside the cell, then (like in #3) the solution outside the cell can be described as hypertonic (low water and high solute concentrations), whereas the solution inside the cell can be described as hypotonic (high water and low solute concentrations). Water should move from a high concentration inside the cell across the membrane towards a low water concentration outside the cell. (So… water is moving from a hypotonic solution to a hypertonic solution). In other words, the cell should lose water and shrink.

*Note: The image at the bottom right corner of the previous page corresponds to BOTH scenarios 3 and 4 because they are the same scenario but with different given information. Scenario 3 identifies the water concentration of the solution outside the cell, whereas Scenario 4 identifies the water concentration of the solution inside the cell.*



1. If the solution outside the cell has the same water concentration as the solution inside the cell, then both solutions can be described as isotonic to one another. Because the water concentration is the same outside and inside the cell, there will be no net (overall) movement of water either into or out of the cell. Water WILL move across the membrane due to random molecular movement, but it will move into and out of the cell at the same rate. In other words, the cell should stay the same size.

Let’s say we are trying to apply our understanding of hypotonic, hypertonic, and isotonic solutions to REAL animal and plant cells. See the descriptions of various scenarios directly below and an image summarizing all the scenarios at the bottom of the next page.

1. If an animal cell is in hypotonic solution (high water), the inside of the cell is hypertonic (low water) compared to the outside solution. Water should move from the outside solution into the cell. If too much water moves in, the animal cell could swell to the point of bursting the cell membrane. This is called lysis and the cell is said to be ***lysed.***
2. If a plant cell is in hypotonic solution, water will move into the plant cell, but it will not burst due to the cell wall. Pressure of the cell membrane on the cell wall due to water coming in is a good thing for the plant cell. This is called turgor pressure and keeps plant stems from wilting. A plant cell in this state is considered ***turgid.***
3. If an animal cell is in isotonic solution, the water concentration outside the cell is the same as the inside of the cell. Water will move into and out of the cell at the same rate, so there is no net (overall) movement of water into or out of the animal cell. In this situation the animal cell maintains the same size / shape.
4. If a plant cell is in isotonic solution, water will move into and out of the cell at the same rate. Because there is not an overall movement of water into the cell, the cell membrane will not push against the cell wall, and the cell is considered ***flaccid.*** In this situation, a plant would begin to wilt slightly.
5. If an animal cell is in hypertonic solution (low water), the inside of the cell is hypotonic (high water) compared to the outside solution. Water should move from the inside of the cell to the outside solution. When water moves out of the cell, the cell shrinks like a raisin in the sun, and the cell is said to be ***shriveled.***
6. If a plant cell is in hypertonic solution, water will move out of the plant cell, and the cell membrane will pull away significantly from the cell wall. In this situation, the cell is considered ***plasmolyzed.*** and the plant as a whole will wilt considerably.

